	Greenwich Mean Right Ascension. h m s	Rad.	G.—R.	Mean N.P.D. ° ′ ″	Rad.	G.—R.
		″	″		″	″
α Cygni	20 36 39·60	39·47	— 0·13	45 13 6·23	7·3	— 1·1
α Cephei	21 15 14·13	14·18	— 0·05	28 0 24·59	24·8	— 0·2
α Aquarii	21 58 35·50	35·49	+ 0·01	90 59 54·48	55·1	— 0·6
α Piscis Australis	22 49 54·38	54·40	— 0·02	120 21 48·31	47·2	+ 1·1
α Pegasi	22 57 47·33	47·33	0·00	75 32 50·49	50·7	— 0·2
α Ursæ Minoris	1 8 3·05	2·37	+ 0·68	1 26 12·90	13·1	— 0·2
δ Ursæ Minoris	18 17 30·19	30·60	— 0·41	3 23 53·19	52·6	+ 0·6

The agreement, on the whole, between the Greenwich places and those of the *Tabulæ Reductionum* appears rather closer than with the *Radcliffe Observations*.

On the Resolvability of Star-Groups, regarded as a Test of Distance. By Richard A. Proctor, B.A.

There are considerations connected with the resolvability of star-groups which have not hitherto received much attention, so far as I am aware. They bear somewhat importantly on the opinions we are to form respecting the distribution of matter throughout the sidereal system.

In the first place, the resolvability of such clustering aggregations of stars as obviously form part of the sidereal system has been regarded as an important means of estimating the relative extension of different parts of that system. So long as a portion of such a clustering aggregation remains unresolved it has been assumed that the limits of the system in that direction lie beyond the range of the telescope which thus fails to effect resolution, and therefore that the extension of the system in that direction is far greater than in other directions where the same telescope shows the stars projected discretely on a perfectly black background.

In the second place, in the case of definite groups of stars, which either lie beyond the limits of the sidereal system, or if within those limits are yet separated from other parts of the system, and surrounded on all sides by relatively barren regions, it has been commonly assumed that we have, in the telescopic powers necessary to effect resolution, a means of forming a general estimate of the distances at which such groups may lie.

It is my purpose here to indicate certain considerations which point to opposite conclusions as respects both these cases.

If we were to accept the conclusion that where a portion of the galaxy is not resolvable with powerful telescopic aid, the sidereal system has a relatively great extension, it would follow from the smallness of the areas which many of these portions of the galaxy present that there is an extension of the system in those directions into long spike-shaped projections, lying in a di-

rection pointing exactly towards the solar system. When Sir William Herschel, for example, speaks of a region of this sort, of limited extent, which his great 40-feet reflector was unable to resolve, we must accept the conclusion that there is one of these spike-shaped projections extending (according to Sir William Herschel's own estimate) no less than 2300 times further into space than a line drawn from the Sun to *Sirius*. It is not only contrary to every law of probability that this is the real state of the case; but even if we could suppose that in this and in other similar instances such spike-shaped projections could *by mere accident* be directed along lines extending radially from the Sun, that is, if we could get over the argument from probability, there would still remain mechanical objections to our believing in such an arrangement. Knowing as we do that all the stars are in motion under the influence of their mutual attractions, and apparently also under the influence of some other and far greater forces adequate to generate the enormous observed motions, we ought scarcely to be willing to recognise in any part of the system a law of distribution which could not result from any conceivable dynamical processes.

It seems more reasonable to conclude that, where a cluster presents the peculiarity considered, there is not enormous longitudinal extension, but a real peculiarity of constitution; that, in fact, the observer has not been penetrating further and further into space as he increased his telescopic power, but simply analysing more and more searchingly a definite region of space.

In fact, Sir William Herschel, in one of his later papers, was led to consider this as perhaps the true explanation of the matter; for in 1817 we find him saying that his star guagings have in reality more direct reference to the condensation than to the distance of the stars, so that a greater number of stars in the field of view may be explained as well by a greater condensation of that portion of the galaxy, as by a greater extension of its figure in that direction in which the stars appear most numerous.*

Now as regards the case of a distinct cluster of stars, let us consider first the effect of distance on a group of stars all equal in magnitude and separated from each other by equal intervals. Supposing such a cluster so placed that the naked eye could recognise each separate orb, and then to sweep rapidly away into space, would it become nebulous or not before vanishing from view? As the group passed away each separate orb would grow less and less bright, and the distances separating orb from orb would grow apparently smaller and smaller. And clearly if these distances became too small to be distinguished, while the stars of the group yet continued visible, there would result a nebulosity of appearance. But suppose that, on the contrary, the stars of the

* It is rather surprising that in nearly all our treatises on astronomy the earlier papers by Sir Wm. Herschel receive far more attention than those he wrote when at the zenith of his fame. There is only one work I know of (Professor Grant's noble *History of Physical Astronomy*), in which Sir W. Herschel's labours are adequately represented.

group became invisible when the group was at such a distance that the intervals separating star from star would not be indistinguishable (if only the stars were brighter). Then clearly the group would vanish with increasing distance without ever becoming nebulous. Clearly also, if a telescope were employed to bring the retreating group into view, the same conclusions would hold good. A group which would become nebulous to the naked eye before vanishing would become so when examined under a telescope, let the telescope's power be what it might, while a group which would vanish without becoming nebulous to the naked eye would not become nebulous before vanishing under telescopic vision, whatever the telescopic power employed.

It is clear, then, that the nebulosity of a star group, whose members are equal and equally distributed, is a question not of distance merely but of constitution, of the relation between the size and brightness of the constituent orbs and the distances which separate them from each other.

But we may extend such considerations to the case of star-groups containing orbs of different orders of magnitude. Supposing a group of this kind to be passing away into space—as in the former case,—the question whether it would become nebulous at any stage or stages of its progress would depend on the question whether or not the order of stars about to disappear individually were congregated so closely that the eye could not distinguish the distances separating them. Clearly also it might be possible that an order of stars *not* about to disappear might present a nebulous appearance, in which case obviously all lower orders still remaining visible would be involved in that nebulous light. Such a cluster, in passing away from the eye, might also be nebulous at a certain distance, and become non-nebulous at a greater distance; all that would be necessary for such a result being that, while some of the lower orders of stars were distributed richly enough to present a nebulous appearance before vanishing, some of the higher orders should be so sparsely distributed as not to present a nebulous appearance before vanishing, or at any rate for some time after the lower orders *had* vanished.

It is further obvious that the same would be true if the retreating group were watched with a telescope of any power whatever (setting aside all question of the extinction of light in passing through space). The same appearances would be presented in precisely the same order when the group passed (star-order by star-order) out of the range of view of any telescope as when it passed out of the range of the unaided vision.

It follows that, if we apply telescopic power to a given group of stars, we can by no means conclude from the nebulosity of the group under such and such power that the group lies at such and such a distance, unless we are prepared to believe in the existence of certain laws of constitution to which all stellar clusters are subject. But such a belief is not likely to find acceptance with those who are acquainted with the observed variety in the constitution of star-groups.

It happens also that we have direct evidence that irresolvable nebulosity affords no proof of relatively enormous distance. When Sir John Herschel was surveying the neighbourhood of the lesser Magellanic Clouds he found that near the edge the Nubecula Minor was irresolvable with the 18-inch reflector, whereas the heart of this Nubecula could be clearly resolved.* Now it needs no proof that, if the Nubecula Minor (setting aside the nebulæ existing within it) were constituted of stars according to the generally uniform laws assigned to the constitution of the sidereal system, the centre of the Nubecula would be the part whose resolution would be most difficult. It is evident, therefore, that the outer parts of the Nubecula are constituted differently from the central region, and the possibility is suggested that the smaller stars seen in the central region belong in reality to the outer shell, whose real character is indicated by the irresolvability of the outer parts of the Nubecula's *disc* (as distinguished from the Nubecula's substance).

In this instance, then, it is distinctly proved that the irresolvability of a celestial region under Sir John Herschel's 20-feet reflector is no proof of relatively enormous distance. But what is thus proved for a certain telescopic power must be true of all telescopic powers. Hence, whatever the power may be under which a certain region appears nebulous, we have no proof that the stars contained within that region are further off than stars within a region resolvable under that power. But since this must be true of all powers, it must be true of naked-eye vision. Hence the stars forming the galaxy are not necessarily further off than those star-groups which the eye can resolve.

One important conclusion which is, I think, fairly deducible from what has been shown, is that, supposing a spiral of small stars such as I have suggested that the milky way may be, should extend along a part of its length, so far from the eye as to become invisible through distance, we ought not to expect that in passing from the visible part to this invisible portion all orders of resolvability down to utter irresolvability in the most powerful telescopes

* I quote the following passages from Sir John Herschel's *Notes on the Nubecula Minor*. They are all I can find which bear on the question of resolvability.

"The edge of the 'smaller cloud' comes on as a mere nebula."

"In the edge of the cloud vision bad, &c. . . . the cloud is not resolved, and seems a very mysterious object."

"We are now in *the cloud*. The field begins to be full of a faint light perfectly irresolvable."

"I should consider about this place the body of *the cloud*, which is here fairly resolved into excessively minute stars, which, however, are certainly seen with the left eye."

"Re-examined by the side motion the whole cloud, in general and in detail. The main body *is* resolved, but barely. I see the stars with the left eye. It is not like the *stippled* ground of the sky. The borders fade away quite insensibly, and are less or not at all resolved. The body of the cloud does not congregate *much* into knots, and altogether it is in no way a striking object apart from the nebula and clusters."

"Upper limit, *but here it is starry, at the other limit nebulous*."

ought to be recognised. On the contrary, this part of the spiral might exhibit in succession all the orders of change which the retreating group considered above was shown to be capable of showing (on a certain, not improbable, assumption as to its structure).

But my object is not so much to find evidence in favour of a special theory about a certain portion of the sidereal system as to indicate the varieties of appearance which are to be looked for in different parts of that system,—varieties which are, in fact, as likely to be met with (according to my views of the nature of that system) around the poles of the galaxy as in the richest portions of that wonderfully complex zone.

On an early Telescope made by Giuseppe Campani of Rome.
By John Williams, Assistant Secretary.

At the sale of the late Dr. Lee's instruments, a few weeks since, I purchased an Italian telescope, which, appearing to be of considerable interest as an example of an early instrument by a then eminent maker, I trust I may be excused calling the attention of the Meeting for a few minutes to it.

On examination I found it to be one constructed by the celebrated Joseph Campani of Rome, who was considered as the best maker of telescopes of his day. Thus we find Cassini and other eminent Astronomers of that time employing instruments made by Campani in their astronomical researches.

I have been unable to find any satisfactory biographical account of this able artist, and can only ascertain that he flourished about the middle of the seventeenth century.

Weidler, in his *Historia Astronomiæ*, 4to, 1741, speaks very highly of Joseph Campani, and particularly notices his observations of *Saturn* and *Jupiter*, as well as his excellence as a maker of telescopes. As the quotation from Weidler is rather long and is in Latin, I shall content myself with the summary of his statement by Dr. Long, as given in his *Treatise on Astronomy*, 4to, 1785. His words are "About this time also (1641) Joseph Campani at Rome applied himself to the grinding of glasses for long telescopes, which far excelled all others of that time. Through the munificence of Louis XIV. Cassini had some made by this artist of 100 and 200 palms. Campani saw the shadow of *Saturn's* ring upon his body, as also his zones or obscure belts, and detected the shadows of *Jupiter's* satellites in passing over his body. It was with one of Campani's telescopes that Cassini first saw all the satellites of *Saturn*." Weidler adds, "Longiora quidem telescopia Campanus pauca fabricavit, in quibus, pro coloribus arcendis, tria vitra ocularia adhibuisse dicitur; attamen etiam breviora quæ composuit, 15, 20, 30 pedes longa, singulari perfectione prædita erant, ut ceteris similibus antecellerent." Which may be rendered, "Campani also made a few longer telescopes, in which to neutra-